BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Greenbelt Park
and
Baltimore-Washington Parkway

2002

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ABSTRACT

In the fall of 2002, USDA Forest Service and USDI National Park Service personnel conducted a gypsy moth egg mass survey at Greenbelt Park and Baltimore-Washington Parkway to assess the potential for defoliation and the need for treatment in 2003. Current populations are sufficient to cause heavy defoliation on approximately 352 acres at Greenbelt Park and on approximately 62 acres at BW Parkway. Treatment is recommended to protect tree foliage and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. Since commuter traffic was high on the BW Parkway, survey plots were located where safe access was available. To help fill in gaps where plots were not established on BW Parkway property, plots established from 2002 fall surveys on adjacent Federal properties were included in determining gypsy moth populations.

At each sample point, a 1/40th acre fixed radius plot was established. An inspection of all egg masses within reach helped estimate the portion of new (2002) to old egg masses at each plot (percent new egg masses). This percentage was applied to the tally of all egg masses observed above the reachable surface. The plots consisted of a tally of all new egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of new egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The locations of the survey plots are shown in Figure 1 for Greenbelt Park and Figures 2a-c for BW Parkway. The summarized results of the survey are presented in Table 1 for Greenbelt Park and Table 2 for BW Parkway.

Egg mass densities per acre throughout the surveyed areas at Greenbelt Park ranged from 0-10,000 and averaged 2,824 egg masses per acre. Overall average egg mass lengths ranged from 23-33 mm and averaged 28 mm. The area where egg mass densities are the highest is located west of the BW Parkway. Egg mass densities in this area of the park ranged from 360-10,000 and averaged 3,631 egg masses per acre. Egg mass lengths averaged 28 mm.

Gypsy moth populations throughout the surveyed areas at BW Parkway ranged from 0-8,120 and averaged 2,164 egg masses per acre. Overall egg mass lengths ranged from 21-36 mm and averaged 30 mm. In areas along the parkway where gypsy moth populations are high, egg mass densities ranged from 280-8,120 and averaged 2,392 egg masses per acre. Egg mass lengths averaged 30 mm in these areas.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as light (1-30 percent), moderate (31-60 percent), and heavy (61-100 percent).

The survey results indicate that heavy defoliation is likely to occur on approximately 352 acres at Greenbelt Park and on approximately 62 acres at BW Parkway (Figures 3a-c).

This defoliation prediction is further supported by using egg density as a means of estimating gypsy moth population densities. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figures 4-5 show how this information can be used to correlate the predicted defoliation of an area. At Greenbelt Park, the average egg mass density of 3,631 egg masses per acre x 28 mm (average egg mass length) translates to a projected defoliation level of about 80 percent (heavy defoliation). At BW Parkway, the average egg mass density of 2,392 egg masses per acre x 30 mm (average egg mass length) translates to a projected defoliation level of about 62 percent (heavy defoliation). This represents an overall average at each site and since egg mass densities and host type are not evenly distributed, actual defoliation will vary somewhat from tree to tree throughout the area.

At Greenbelt Park the average egg mass length is 28 mm. At BW Parkway the average egg mass length is 30 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious sign of stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. Both the fungus and virus were observed in the general location of these two sites in 2002 and it is possible that either could cause a general collapse next year. However, a population collapse is not likely to occur prior to a significant defoliation event in 2003.

Predicting the extent of tree mortality that would result after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) and the Cuyahoga Valley National Park (2002) provide examples of potential tree mortality. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. At Cuyahoga Valley National Park following one year of heavy defoliation, significant mortality occurred in approximately 25 percent of the defoliated areas. In the mortality areas, oak mortality ranged from 22-98 and averaged 54 percent. In these examples, droughty conditions likely contributed to the level of mortality.

Management Options

For 2003, two management options have been evaluated for managing gypsy moth populations at Greenbelt Park and BW Parkway. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage and prevent tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with information at hand, it is unlikely that a collapse will occur prior to defoliation

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that heavy defoliation will occur at Greenbelt Park and BW Parkway in 2003.

Microbial Insecticide Option

Btk**:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it can be difficult to project treatment

efficacy with less than optimal conditions following treatment. Most often foliage protection is achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, or a single application at 4×10^{11} OB's. When supplies are limited, priority is given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There will be an adequate supply of Gypchek in 2003 however.

Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1 - No action

Alternative 2 - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3 - Two aerial application of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4 - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre.

Alternative 5 - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations sufficient to cause heavy defoliation on approximately 352 acres at Greenbelt Park and on approximately 62 acres at BW Parkway in 2003 (Figure 3a-c). To help protect tree foliage and prevent possible tree mortality, our recommendation is Alternative 4 (a single application of Gypchek). This recommendation is based on the following considerations:

1. A single application of Gypchek will likely provide adequate foliage protection and reduce the existing population below the treatment threshold.

2. The cost of a single application of Gypchek is about one half that of a double application of Gypchek.

3. Gypchek is host specific which minimizes the risk to other non-target organisms including lepidopteran caterpillars.

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Table 1. Gypsy moth egg mass survey results at Greenbelt Park, Fall 2002.

Plot Number	Average Em/Acre	Average Em length (mm)	Percent New
*1	2,440	28	84
*2	4,280	24	91
*3	3,000	29	78
*4	5,520	30	86
*5	400	29	78
*6	720	33	80
*7	4,640	28	100
*8	880	--	75
*9	360	--	100
*10	5,840	28	95
*11	2,320	32	100
*12	8,120	26	92
*13	1,600	29	64
*14	1,600	31	95
15	400	23	100
*16	5,680	23	89
*17	4,320	27	89
*18	10,000	23	100
19	0	--	--
20	0	--	--
21	0	--	--
22	0	--	--

Overall egg masses/acre range =0-10,000
Overall egg masses/acre average = 2,824
Range of average egg mass length (mm) = 23-33
Average egg mass length (mm) = 28

* Located within proposed treatment area

Egg masses/acre range in proposed treatment area = 360-10,000
Egg masses/acre average in proposed treatment area = 3,631
Average egg mass length in proposed treatment area = 28 mm

Table 2. Gypsy moth egg mass survey results at Baltimore-Washington Parkway, Fall 2002.

Plot Number	Average Em/Acre	Average Em length (mm)	Percent New
*1	1,760	25	97
*2	3,760	32	89
*3	720	33	80
*4	4,640	28	100
*5	8,120	26	92
*6	280	23	50
*7	760	35	100
*8	280	25	100
*9	5,640	29	100
*10	7,200	25	87
*11	1,800	30	100
*12	2,440	28	94
*13	560	36	100
*14	1,440	29	93
*15	1,760	29	79
*16	1,080	21	75
*17	560	36	86
18	0	--	--
*19	1,280	33	--
*20	1,360	32	--
21	0	--	--

Overall egg masses/acre range =0-8,120
Overall egg masses/acre average = 2,164
Range of average egg mass length (mm) = 21-36
Average egg mass length (mm) = 30

* Located within proposed treatment area

Egg masses/acre range in proposed treatment area = 280-8,120
Egg masses/acre average in proposed treatment area = 2,392
Average egg mass length in proposed treatment area = 30